

TITLE OF INVENTION

CLUSTER ASSEMBLY

by

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CROSS-REFERENCES TO RELATED APPLICATIONS

None.

10 STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

None.

15 REFERENCE TO A MICRO-FICHE APPENDIX

None.

BACKGROUND OF THE INVENTION

20 Field of the Invention

The present invention relates generally to the field of contact assemblies for switchgear apparatus, and more specifically to cluster assemblies for both low and medium voltage applications which allow a movable circuit breaker to connect to a fixed part of the switchgear.

BRIEF SUMMARY OF THE INVENTION

30 Switchgear assemblies for both low and medium voltage applications use contact assemblies that allow a movable circuit breaker to connect to a fixed part of the switchgear. The means

of making this connection is accomplished by copper fingers that
are spring loaded and which bridge between conductors of uniform
geometrical shape including, but not limited to round and
rectangular conductors. Many different types of springs are used
5 in these assemblies including compression, tension and leaf
styles. For each embodiment of the present invention, the means
of retaining the fingers and springs has varied widely as
required to satisfy the particular size and geometry of
conductor.

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BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a perspective view of a finger element of an
embodiment of the present invention.

Fig. 2 is a perspective view of a finger spring element of
an embodiment of the present invention.

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Fig. 3 is a perspective view of a resilient finger spring
assembly of the finger element depicted in Fig. 1 and the spring
element depicted in Fig. 2.

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Fig. 4 is a perspective view of a partial assembly of the
finger and spring assembly, locator, and guide of an embodiment
of the present invention.

Fig. 5 is a side view of disconnected cluster assembly of an
embodiment of the present invention.

Fig. 6 is a side view of connected cluster assembly of an
embodiment of the present invention.

Fig. 7A is a perspective view of a 12 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 7B is an end view of typical locator plate for a 12 finger rectangular cluster assembly of an embodiment of the
5 present invention.

Fig. 7C is an end view of typical guide plate for a 12 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 8A is a perspective view of a 24 finger rectangular
10 cluster assembly of an embodiment of the present invention.

Fig. 8B is an end view of typical locator plate for a 24 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 8C is an end view of typical guide plate for a 24 finger rectangular cluster assembly of an embodiment of the
15 present invention.

Fig. 9A is a perspective view of a 58 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 9B is an end view of typical locator plate for a 58 finger rectangular cluster assembly of an embodiment of the
20 present invention.

Fig. 9C is an end view of typical guide plate for a 58 finger rectangular cluster assembly of an embodiment of the present invention.

Fig. 10A is a perspective view of a 20 finger circular cluster assembly of an embodiment of the present invention.

Fig. 10B is an end view of typical locator plate for a 20 finger circular cluster assembly of an embodiment of the present invention.

Fig. 10C is an end view of typical guide plate for a 20 finger circular cluster assembly of an embodiment of the present invention.

Fig. 11A is a perspective view of a 36 finger circular cluster assembly of an embodiment of the present invention.

Fig. 11B is an end view of typical locator plate for a 36 finger circular cluster assembly of an embodiment of the present invention.

Fig. 11C is an end view of typical guide plate for a 36 finger circular cluster assembly of an embodiment of the present invention.

Fig. 12A is a perspective view of a 54 finger circular cluster assembly of an embodiment of the present invention.

Fig. 12B is an end view of typical locator plate for a 54 finger circular cluster assembly of an embodiment of the present invention.

Fig. 12C is an end view of typical guide plate for a 54 finger circular cluster assembly of an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The apparatus of the present invention comprises a primary finger 10 as depicted in Fig. 1. The primary finger 10 is produced by stamping or similar high volume process from high conductivity copper. The primary finger 10 is common to all designs or embodiments of the present invention so that economical high volume production methods can be employed. The primary finger 10 further comprises a predetermined width, a predetermined length, a center point midway along the finger 10 length, two ends, a top side comprising a circular spring locator 12 located at one end of the finger top side, and a bottom side comprising a locator slot 14 located at the end of the bottom side opposite from the end of the finger having the circular spring locator 12 and a guide slot 16 located on the finger 15 bottom at a point slightly off the center point of the finger towards the locator slot 14. The preferred embodiment of finger 10 is 0.155 inches thick; however a specific thickness is not necessarily determinative of how the finger functions. As shown, for example in Fig. 7C, the slot width 150 in which one or more fingers 10 will be inserted is sized to accommodate the number of fingers desired per slot and the total finger width. The finger 20 end opposite the end of the locator slot 14 is angled at 45 degrees to form a conical or ramped shaped tip 19, Figs. 1 and 5.

A finger spring 20, Fig. 2, of an embodiment of the present invention comprises a formed circular end 22, a deformed convex top side 24, a deformed concave bottom side 26, and a foot end 28, wherein the deformed top and bottom sides define a leaf spring mechanism. The preferred embodiment of finger spring 20 is made of spring steel and is 18 gauge thick, 0.150 inches wide, and about 2 inches long to provide the requisite load contact force in the deformed state. The finger spring 20 is also common to all designs or embodiments of the present invention and again high volume production methods allow for an economical part.

As shown in Fig. 3, the finger 10 and spring 20 are assembled by locating the formed circular end 22 of the spring 20 into the circular spring locator 12 of the finger 10, aligning the spring leaf so that the spring convex top side 24 bows above the finger top side, and the spring foot 28 rests on the finger top side providing the resilient finger spring assembly 30.

In order to retain the finger spring assembly 30 and have it cooperate with the fixed side of a conductor, two flat metal plates constructed from non-magnetic steel are used, Figs. 4 - 6. Both plates comprise front and back surfaces which are identically sized by width and length and which have identical geometries. Both plate surfaces further comprise plate edges of a predetermined plate thickness, and have an array of identically

sized and located slots 150. One of the two plates is a locator plate 60 and the other plate is a guide plate 70. The locator plate comprises means by which it can be fixedly connected to the fixed part of the conductor 400.

5 The locator plate 60 further comprises means to attach to the guide plate 70 other than the resilient finger spring assemblies on certain embodiments of the present invention. For example, where locator and guide plate geometries are rectangular, the means by which the locator plate 60 cooperates with the guide plate 70 further comprises two fixed arms 67 extending at right angles from the locator plate 60 front surface for a predetermined length such that it extends past the guide plate 70. The guide plate 70 further comprises two notches on each side that the locator plate fixed arms 67 pass through. The 10 dimension between the fixed arms 67 is larger than the distance between the vertical surfaces of the two notches of the guide plate 70. The clearance resulting from the difference between the two dimensions limits the side-to-side motion of the guide plate 70 and thus the outer ends of each finger 10. The 15 dimensional height of the fixed arms 67 is also slightly smaller than the dimensional height of the guide plate side notches. Again the clearance between these corresponding elements limits 20 the up and down motion of the guide plate and thus the outer,

tapered tips 19 of the fingers 10. Limiting the side-to-side and up and down motions of each finger 10 is critical to ensure that each finger 10 aligns with the conductor 200 so that each finger 10 properly engages with the conductor 200 but the clearance also 5 allows for some misalignment between conductors 200 and 400.

The cluster assembly is held together by the location of the finger slots 14 and 16 in each of the locator plate 60 and the guide plate 70, respectively, and the action of the finger spring 20 holding them in place. The resilient finger spring assembly 10 position allows sufficient movement of the oppositely opposed resilient finger spring assembly to receive and engage the movable conductor element tapered tip and full element width, and wherein such oppositely opposed pair of resilient finger spring assemblies for rectangular locator and guide plate geometries 15 define a gap distance between the tapered finger assembly edges which is smaller than the width of the movable conductor element. In the case of the circular cluster assemblies and locator/guide plate geometries, Figs. 10A - 12C, the circular array of the resilient finger spring assemblies and the dimensions of the 20 parts both limit the total motion of the fingers relative to the centerline of the assembly but allow for misalignment of the conductor centerlines.

In an embodiment of the present invention, Figs. 4, 5, 8B, and 8C, the locator plate 60 and the guide plate 70 are each 10

gauge thick, and the means by which the locator plate can be fixedly connected to the fixed part of the conductor further comprises locator plate openings 65 and guide plate openings 69 for receiving means to bolt the plate to the conductor 400. In 5 an embodiment of the present invention using rectangular locator and guide plate geometries, the means by which the locator plate 60 connects to the guide plate 70 further comprises two fixed arms 67 extending at a right angles from the locator plate 60 front surface for a predetermined length towards the locator 10 plate 60 rear surface and beyond, and terminating in connection with the guide plate 70 notched edges. The predetermined length of the fixed arms 67 corresponds to the distance between the finger locator slot 14 and the finger guide slot 16 so that when the locator plate 60 is attached to the guide plate 70, each 15 finger slot can receive its respective plate when the finger is positioned into one of the array of corresponding plate slots. These locator and guide plates can be manufactured using numerically controlled laser cutting equipment known in the art. This production process easily can vary the plate sizes and 20 shapes to economically produce smaller numbers of parts.

As shown in the partial assembly of an embodiment of the present invention using rectangular locator/guide plate geometries, Figs. 4, 8B, and 8C, after the locator plate 60 has been attached to the guide plate 70 by means of securing the

locator plate arms **67** into the guide plate notches **69**, one finger spring assembly **30** is located in the first slot in the array of plate slots of a partial assembly. The locator slot **14** in the finger bottom is positioned such that the locator plate **60** fits
5 in to the locator slot **14** and holds the spring assembly **30** in place, Figs. 4 - 6. As depicted in Figs. 4 and 5, the leaf spring contacts the guide plate **70** at the top of the respective guide plate slot while the finger guide slot **16** receives the guide plate, wherein the guide plate also secures the spring
10 assembly **30**. The finger guide slot **16** depth is such that the leaf spring is deformed from its free state and therefore holds the finger **10** against the bottom of the respective guide plate slot. With this configuration, Fig. 5, the finger **10** is held so that it is at an approximate 4 degree angle of declination
15 measured from the centerline of the conductor **200** in a disconnected state. In the disconnected state, the conductor centerlines are misaligned. The conductor cross-sections are either round or rectangular; however the cross-section of the conductor **400** to which the locator plate **70** is fixedly attached
20 is the same as the cross-section of the conductor **200** to which the cluster assembly engages. As further depicted in Fig. 5, at this 4 degree angle of declination, the gap between the two fingers is smaller than the width of the conductor **200** to be

received. Once the cluster assembly engages the conductor 200 and is connected, the finger spring 20 further deforms and the finger 10 angle becomes nearly parallel to the centerline of the conductor 200, Fig. 6, and the conductor centerlines are then
5 aligned.

The tip of the conductor 200 to be received is shaped with corresponding 45 degree angles so that each finger end 19 engages the conductor 200 first at this angled tip, Fig. 5. Once the cluster 40 is connected to the conductor 200, Fig. 6, the
10 corresponding finger 10 of the finger spring assemblies 30 moves to a parallel position relative to the conductor 200 centerline. The top of the corresponding guide plate 70 slot further causes deformation of the resilient finger spring 20 and each finger 10 now contacts both conductors. The force on each conductor is
15 equal since the guide plate 70 is midway between the raised contact sections of the fingers. The force exerted in the connected cluster is sufficient to ensure good contact between the fingers and the conductors and to allow transfer of electrical current between the two conductors.

20 Low and medium switchgear require differing levels of rated normal current be carried. These rated currents range from 600 amps to as much as 6,000 amps. The sizes and shapes of conductors to adequately carry this range of current vary and no

single design is possible. A number of possible embodiments are depicted in Figs. 7A - 12C. All of these embodiments use the same primary finger and finger spring components which can be produced in high volume and low cost. Each of the corresponding 5 locator plates and guide plates are shaped and sized to suit the conductor profile employed for the specific current rating and type of circuit breaker. The locator plates and guide plates are manufactured by a process which easily and economically can produce the lower volume variable parts. As depicted in figs. 7A 10 - 12C, it is possible to install more than one resilient finger spring assembly in each plate slot. Up to four resilient finger spring assemblies per slot have been successfully used, though four is by no means a limit. As depicted in Figs 10A - 12C, the circular locator and guide plates do not require attachment means 15 between the plates other than the resilient finger spring assemblies, and the circular guide plates do not require access means to bolt the plate assemblies to the fixed conductor since the guide plate opening itself provides this access. The suitable array of locator/guide plate slots and the number of 20 resilient finger spring assemblies per slot are determined by the current rating desired.

Therefore, the disclosed invention provides cluster assemblies for switchgear which are uncomplicated, use few and easily manufactured parts, achieve a high degree of precision

location and orientation, and eliminate design complexity and tedious assembly procedures. It will be understood that, while presently preferred embodiments of the invention have been illustrated and described, the invention is not limited thereto,
5 but may be otherwise variously embodied within the scope of the following claims.